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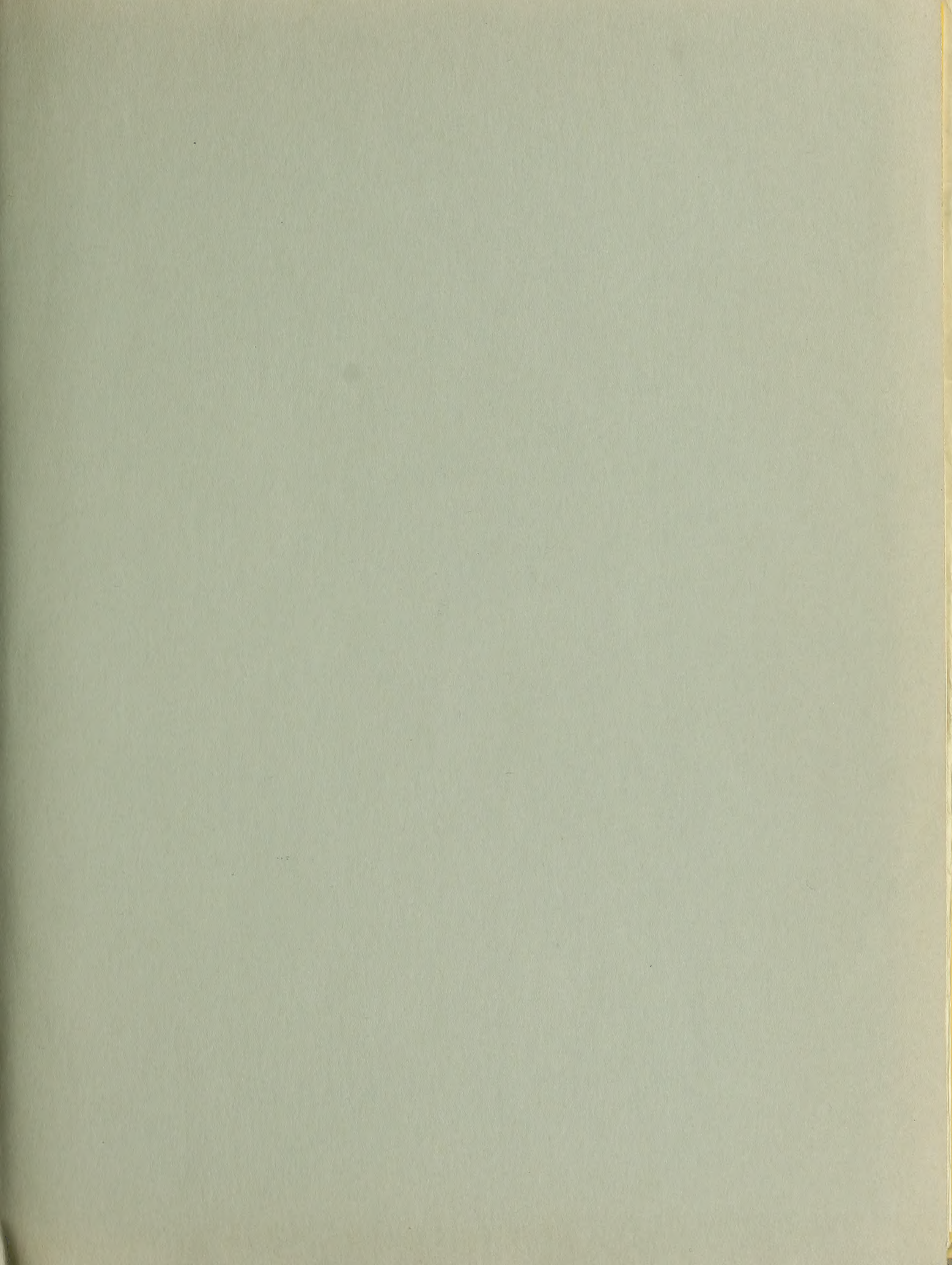
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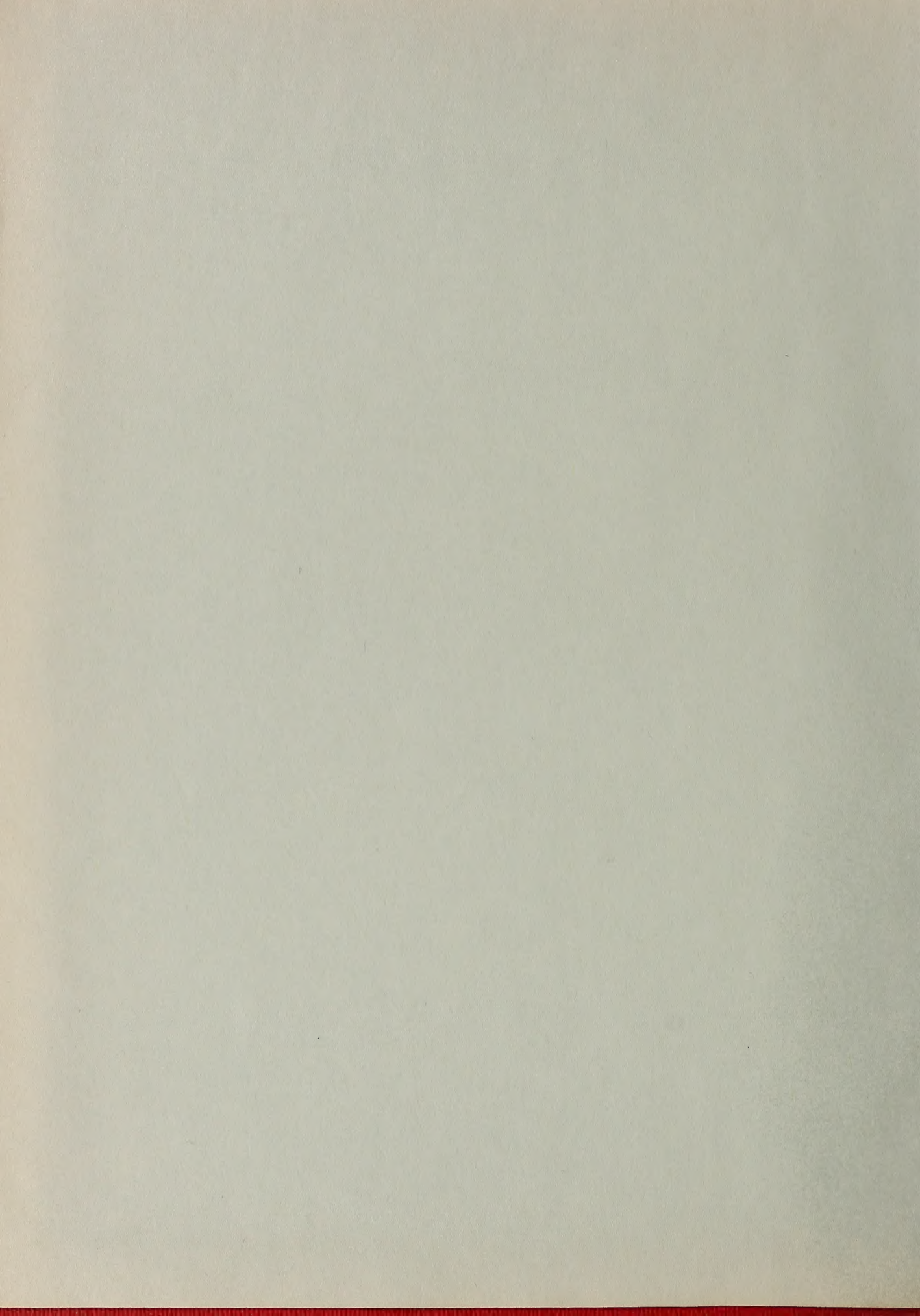
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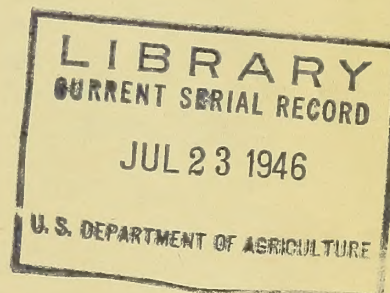
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REPORT ON A TRANSPORTATION TEST WITH DELICIOUS APPLES
UNDER HEATER SERVICE FROM WENATCHEE, WASH. TO JERSEY
CITY, NEW YORK CITY AND PHILADELPHIA: A COMPARISON
OF THE PERFORMANCE OF TWO TYPES OF REFRIGERATOR CARS
AND FIVE KINDS OF CAR HEATERS, JANUARY 1946

(A Summary of the Most Outstanding Results and
Observations)

By

Fisk Gerhardt, Physiologist, and
Harley English, Assistant Pathologist



Beltsville, Md.
February 6, 1946

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REPORT ON A TRANSPORTATION TEST WITH DELICIOUS APPLES UNDER HEATER SERVICE FROM WENATCHEE, WASH. TO JERSEY CITY, NEW YORK CITY AND PHILADELPHIA: A COMPARISON OF THE PERFORMANCE OF TWO TYPES OF REFRIGERATOR CARS AND FIVE KINDS OF CAR HEATERS, JANUARY 1946

(A summary of the most outstanding results and observations)

The purpose of this test was to study the performance of three types of thermostatically controlled alcohol heaters, a charcoal heater with thermostatic draft control, and a standard charcoal heater, in standard refrigerator cars and in similar refrigerator cars equipped with Preco fans. The influence of car performance during transit was also evaluated in terms of changes in the dessert quality of comparable test lots of fruit of known storage history that were carried at the same position in each of the test cars.

An outline of car and heater operation is shown in table 1. Eight commodity and four air temperatures at various positions in each car were taken by means of electric resistance thermometers read from the outside of the car. These thermometers were placed as follows:

Commodity

Bottom bunker, north side, A-end
" " " " B-end
Top bunker, centerline, A-end
" " " B-end
Top quarterlength, centerline, A-end
" " " B-end
" Door, centerline
Bottom door, north side

Air

Bottom bunker, north side, A-end
" " " " B-end
" door, north side
Top quarterlength, centerline

The cars used were selected for uniformity of design and size insofar as this was possible. All of them were 40 feet in length, and each had 3-1/2 inches of insulation in the floor and roof, and 3 inches in the sides and ends. The inside height of the fan cars was 7 ft. 6 in., and of the standard cars 6 ft. 10 in. In the latter the floor racks were 5 inches high and the bottom bulkhead openings 12-1/2 inches high. In the fan-equipped cars the floor racks were 7-1/2 inches high and the bottom bulkhead openings 6 inches high and therefore entirely beneath the floor racks. The other dimensions of all cars were similar.



The cars were loaded in the Wenatchee-Okanogan district on January 15, 1946, and moved to destination via the Great Northern, Chicago, Burlington and Quincy, and Pennsylvania Railroads. Each car contained a solid load of standard boxes of Delicious apples, the number of boxes per car varying from 798 to 854. The distance from the top of the load to the ceiling was 6-1/2 inches in the standard cars and 17 inches in the fan cars. All cars were loaded with side-wall air spaces of 4 to 6 inches.

Observations

Heater Difficulties. Before the temperature records are discussed, mention should be made of certain difficulties and irregularities that affected operations of some of the heaters. The thermostats of the alcohol heaters were set originally at 32° F. and those of the M. P. charcoal heaters with thermostatic draft control at 36°. Dangerously low commodity temperatures observed at New Rockford and Hannaford in the cars equipped with PFE alcohol heaters necessitated raising the thermostatic setting of these heaters from 1° to 3°. With the advent of warmer weather at Savanna the thermostats were reset at 32°. Through an oversight, the heaters in BRE 74616 were not lighted following refueling at Willmar, but were relighted at Dayton's Bluff. Float difficulty in one of the Solar alcohol heaters located in WFE 66454 was found and corrected at Hillyard. Later it was necessary to replace a broken fuel line in the same heater. At Savanna the pilot light of this heater was found extinguished, presumably because of the dripping of condensation moisture from the bunker ceiling. It was relighted at Blue Island. One of the standard charcoal heaters in EGE 35284 was found to be dark at Willmar, undoubtedly because of fuel bridged across the throat of the magazine. It was relighted before departure.

Heater Weather

Outside temperatures encountered during the test are shown in table 2. They should be considered average to mild, and probably quite representative of usual heater weather.

Commodity Temperatures and Car Performance

The temperature records of the various test cars are presented in the attached charts. In the fan-equipped cars, best temperature records were obtained when heaters and fans were operated in both ends of the car. A wide spread in commodity temperatures resulted from fan operation in the rear end and heat application only in the head end of the car. Using both fans and only one heater gave more satisfactory commodity temperatures than using one fan and two heaters. The thermo-charcoal heater produced higher maximum commodity temperatures than did the thermo-alcohol type when the heater was operated in one end of the car and the fan in the other end.



In most of the cars equipped with PFE alcohol heaters, dangerously low commodity temperatures were found in fruit next to the floor racks along the north side of the car. No freezing, however, was reported in any of the fruit at time of unloading.

In the standard cars, the WFE alcohol heater gave superior performance. Spread in commodity temperatures in this car compared favorably with that in some of the better operated fan cars. The charcoal heater with thermostatic draft control gave slightly better performance than the standard charcoal heater. In the standard car in which the PFE thermo-alcohol heater was used, dangerously high and dangerously low commodity temperatures were found.

For the purpose of rapid comparison, critical commodity temperatures in the various test cars are summarized in table 3. With the exception of four cars, all minimum average bottom commodity temperatures were dangerously low.

Heater Performance

No evidence was found of more rapid fuel consumption, pilot light failure, or other heater difficulty as a result of the operation of the fans. Commodity temperatures in cars equipped with Solar heaters indicate that the heat output of the pilot light should be reduced. Dangerously low fruit temperatures in certain cars also indicated that special attention should be given to making the thermostats more accurate and dependable in operation. This was made evident in the performance of some of the heaters using liquid fuels.

Fuel Consumption

Data on fuel consumption of the various types of heaters under test are summarized in table 4. Consumption of liquid fuel varied from about 9 to 14.5 gallons per car. There was no appreciable difference in the amount of fuel consumed in the two types of charcoal heaters under test.

Observations at Time of Unloading

When the cars were unloaded the test boxes of apples were removed to the Department of Agriculture laboratory in New York, where data were taken on firmness, composition and dessert quality of the fruit. This part of the investigation has not yet been completed.

Considerable shifting of the load was noted in all of the test cars. This was due in part to inadequate stripping. In some cases serious breakage occurred at the doorway where the load was lower. In two cars the bunker bulkhead at one end was damaged by rough switching. The exposed lids of many boxes adjacent to the side wall air spaces had sprung open sufficiently to release considerable fruit along the side walls of some cars.



Acknowledgments

Besides the writers the test party consisted of the following, all of whom accompanied the cars from Wenatchee and to whom thanks are expressed for their helpful cooperation:

- A. A. Hamer, General Mechanical Inspector, Western Fruit Express Co.,
Alexandria, Virginia
- Ray Doering, Test Engineer, Pacific Fruit Express Co., San Francisco,
California
- Charles Boyd, Chief Refrigerating Engineer, Northern Pacific Railroad,
St. Paul, Minnesota
- C. S. Markee, Service Engineer, Solar Aircraft Co., San Diego, California
(at request of Northern Pacific Railroad)

The writers also express appreciation for the assistance and cooperation of the following staff associates located at the Bureau's laboratory in New York City:

- C. O. Bratley
- J. S. Wiant
- E. V. Shear
- J. Kaufman

Thanks are expressed to the following shippers who cooperated by furnishing commercial consignments to be used in the tests:

- Driver and Woodrow
Wenatchee-Okanogan Cooperative Federation
- J. M. Wade
Justman-Frankenthal Co.
- Fruit Growers' Service Co.

The test was made possible and conducted to a successful conclusion only by the generous cooperation and assistance of the railroads and car lines named below to whom grateful acknowledgment is made:

- Great Northern Railway
- Chicago, Burlington & Quincy Railroad
- Pennsylvania Railroad
- Western Fruit Express Co.
- Northern Pacific Railroad
- Pacific Fruit Express Co.

Acknowledgment is also made of the helpful assistance of Mr. H. H. Foreman, Service Agent, Interstate Commerce Commission who accompanied the test as an official observer for that agency and assisted in the collection of the data.



Table 1. Car line-up for Heater Transportation Test Trip
(Wenatchee, Wash. to Jersey City, N. J. January 16-26, 1946)

Number	Car		Fan Operation	Kind of Heater	Position of Heater	Drains
	Type					
WFE 66454	Fan		Rear only	Solar alcoheater	1 front 1 rear	2 plugged on north side 2 open on south side
WFE 66501	Fan		Both ends	PFE Thermo-alcohol	Front regular front standby	2 plugged on north side 2 plugged on south side
WFE 66471	Fan		Both ends	PFE Thermo-alcohol	1 front 1 rear	2 plugged on north side 2 open on south side
WFE 74616	Fan		Rear only	PFE Thermo-alcohol	Front regular front standby	2 plugged on north side 2 open on south side
WFE 74579	Fan		Rear only	N.P. Thermo-charcoal	Front regular front standby	All drains plugged
WFE 74602	Fan		Both ends	Solar alcoheater	1 front 1 rear	2 plugged on north side 2 open on south side
WFE 35284	Standard		None	Standard WFE charcoal	1 front 1 rear	All drains plugged
WFE 65184	Standard		None	PFE Thermo-alcohol	1 front 1 rear	2 plugged on north side 2 open on south side
WFE 65570	Standard		None	WFE Thermo-alcohol	1 front 1 rear	2 plugged at diagonal ends of car
WFE 65877	Standard		None	N.P. Thermo charcoal	1 front 1 rear	All drains plugged

Table 2.-Temperature Record - Test Train From Wenatchee, Wash.
January 16, 1946

Place	Time of reading	Date	Outside Temperature
Ephrata	9:50 p.m. PT	1-16	30
En route	11:30 a.m.	17	37
Troy	5:15 p.m.	17	34
En route	6:15 p.m. MT	17	30
En route	9:00 p.m.	17	30
En route	10:45 p.m.	17	24
Cutbank	10:00 a.m.	18	36
En route	10:45 a.m.	18	42
En route	1:30 p.m.	18	29
En route	11:15 p.m.	18	20
En route	7:30 a.m.	19	10
Oswego	8:00 a.m.	19	16
En route	10:30 a.m.	19	29
En route	11:00 a.m.	19	30
En route	9:15 p.m. CT	19	12
En route	11:00 p.m.	19	4
Berthold	1:00 a.m.	20	0
En route	1:45 a.m.	20	2
En route	3:00 a.m.	20	0
En route	4:30 a.m.	20	0
Brantford	3:15 p.m.	20	-2
Hannaford	6:35 p.m.	20	-7
Breckenridge)	3:50 a.m.	21	-8
Breckenridge)	4:45 a.m.	21	-10
Benson	10:40 a.m.	21	-4
En route	4:20 p.m.	21	-2
En route	5:10 p.m.	21	-4
Daytons Bluff	1:40 a.m.	22	-5
En route	9:00 a.m.	22	-2
En route	10:30 a.m.	22	6
En route	6:00 p.m.	22	16
En route	8:50 p.m.	22	19
En route	7:25 a.m.	23	21
En route	9:15 a.m.	23	23
En route	1:00 p.m.	23	31
En route	8:30 a.m.	24	30
En route	8:45 p.m.	24	34
Pitcairn	2:45 a.m.	25	30
Enola	10:00 a.m.	25	36

Table 3.- Critical Commodity Temperatures

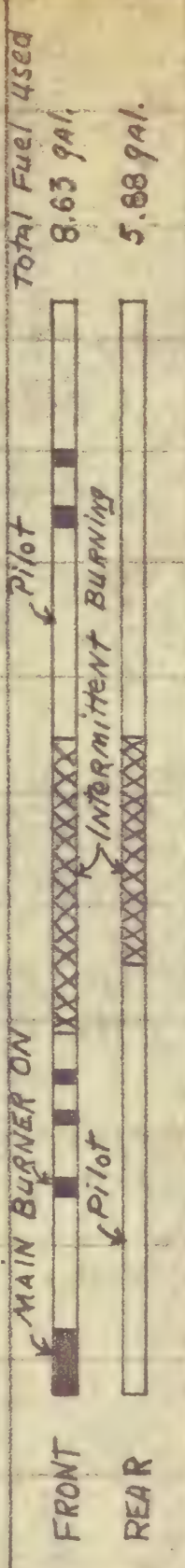
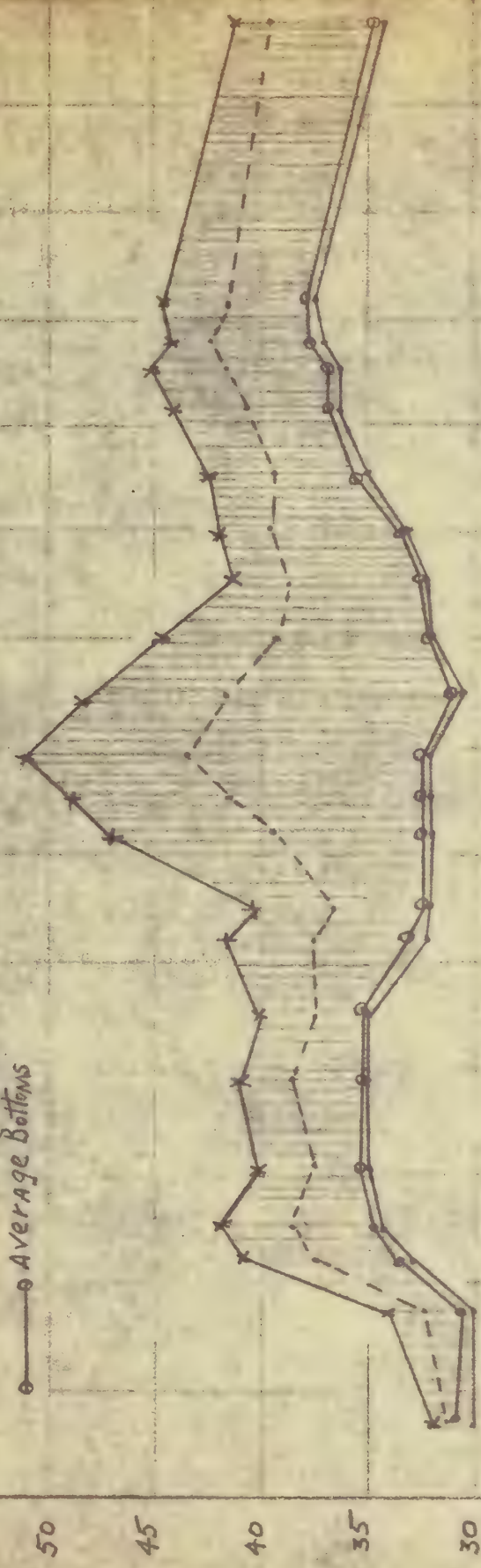
Car Number	Car Type	Fan Operation	Kind of Heater	Position of Heater	° F.			° F.	
					Maximum	Minimum	Spread	Maximum Average Top	Minimum average Bottom
WFE 66454	Fan	Rear end	Solar alcohol	Front rear	51.0	30.5	20.5	43.8	30.7
WFE 66501	Fan	Both ends	PFE alcohol	Front-regular Front-standby	42.5	27.0	15.5	39.3	27.5
WFE 66471	Fan	Both ends	PFE alcohol	Front Rear	40.0	27.0	13.0	37.2	27.6
BRE 74616	Fan	Rear end	PFE alcohol	Front-regular Front-standby	48.0	27.0	21.0	39.7	27.1
BRE 74579	Fan	Rear end	N. P. Thermo- charcoal	Front-regular Front-standby	53.0	28.0	25.0	42.3	28.6
BRE 74602	Fan	Both ends	Solar alcohol	Front Rear	43.5	29.5	14.0	42.1	29.8
FGE 35284	Standard	None	WFE Standard charcoal	Front Rear	51.0	26.0	25.0	47.0	26.3
WFE 65184	Standard	None	PFE alcohol	Front Rear	63.5	26.0	37.5	52.8	26.3
WFE 65570	Standard	None	WFE alcohol	Front Rear	45.5	29.0	16.5	41.2	29.5
WFE 65877	Standard	None	N. P. Thermo- charcoal	Front Rear	48.0	26.5	21.5	43.2	26.8

Table 4.--Fuel Consumption Record

Car		Type	Kind of Heater	Position of Heater	Heater Number	Fuel Consumed	Total Fuel Consumed Per Car
Number							
WFE 66454	Fan	Solar alcohol	Front Rear	9 7	8.63 gal. 5.88 "	14.51 gal.	
WFE 66501	Fan	PFE alcohol	Front-Regular Front-Standby	B-320 B-398	8.38 gal. 1.13 "	9.51 "	
WFE 66471	Fan	PFE alcohol	Front Rear	B-322 B-339	4.88 " 4.88 "	9.76 "	
BRE 74616	Fan	PFE alcohol	Front-Regular Front-Standby	B-342 B-310	6.62 " 2.63 "	9.25 "	
BRE 74579	Fan	N.P. thermo- charcoal	Front-Regular Front-Standby	348 333	26.0 lbs. 22.0 "	48.0 lbs.	
BRE 74602	Fan	Solar alcohol	Front Rear	3 16	6.38 gal. 5.63 "	12.01 gal.	
WFE 35284	Standard	WFE standard charcoal	Front Rear	S-1767 S-4357	22.5 lbs. 24.0 lbs.	46.5 lbs.	
WFE 65184	Standard	PFE alcohol	Front Rear	B-369 B-326	8.75 gal. 3.25 "	12.0 gal.	
WFE 65570	Standard	WFE alcohol	Front Rear	37 35	6.13 gal. 2.75 "	8.88 gal.	
WFE 65877	Standard	N.P. thermo- charcoal	Front Rear	267 290	22.0 lbs. 25.5 lbs.	47.5 lbs.	

Temperature of.

- × Maximum
- Minimum
- - - Average Tops
- Average Bottoms



Date	Place
16	Wash. Point
17	AppleYard
18	Hillyard
19	Whitefish
20	HARVE
21	Williston
22	MINOT
23	New Rockford
24	Breckenridge
25	WILLMAR
26	DAYTON Bluff
27	E WINONA
28	SAVANNA
29	Blue Island
30	DAITON
31	Columbus
32	PITCAIRN
33	ALTONA
34	ENOIA
35	Jersey City
36	N.Y. Pier 29

DATE AND PLACE

TEMPERATURE ° F.

x x x Maximum
 ——— Minimum
 - - - Average Tops
 o o o Average Bottoms



Total Fuel Used
 8.38 gal.
 1.13 gal.

REGULAR [] MAIN BURNER ON
 STANDBY [] INTERMITTENT BURNING

Pilot
 DARK

16 17 18 19 20 21 22 23 24 25 26 27 28
 JANUARY

LOADING PAINTS WASH.
 Appleyard
 Hilliard
 Whitefish
 Havre
 Williston
 Minot
 New Rockford
 Breckenridge
 Willmar
 Dayton Bluff
 E. WINDONA
 SAVANNAH
 Blue Island
 Dutton
 Columbus
 Pitcairn
 A/foona
 Enola
 Diversted to Philadelphia

Date and Place

x MAXIMUM
 — MINIMUM
 - - - Average Tops
 o Average Bottoms

55
 50
 45
 40
 35
 30
 25
 HEATER
 RECORD

TEMPERATURE



TOTAL FUEL USED
 26 Lbs.
 22 Lbs.



16 17 18 19 20 21 22 23 24 25 26 27 28
 JANUARY

LOADING POINTS WASH	Abbeyard	Hillyard	Whitefish	HAVRE	Williston	THINOT	New Rockford	Breckenridge	WILLMAR	Dayton Bluff	E. WINONA	SARANNA	Blue Island	DALTON	Columbus	PICAIRN	ALTONA	ENOIDA	Jersey City	Jersey City Lim loading
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DATE AND PLACE



CAR - BRE 79616

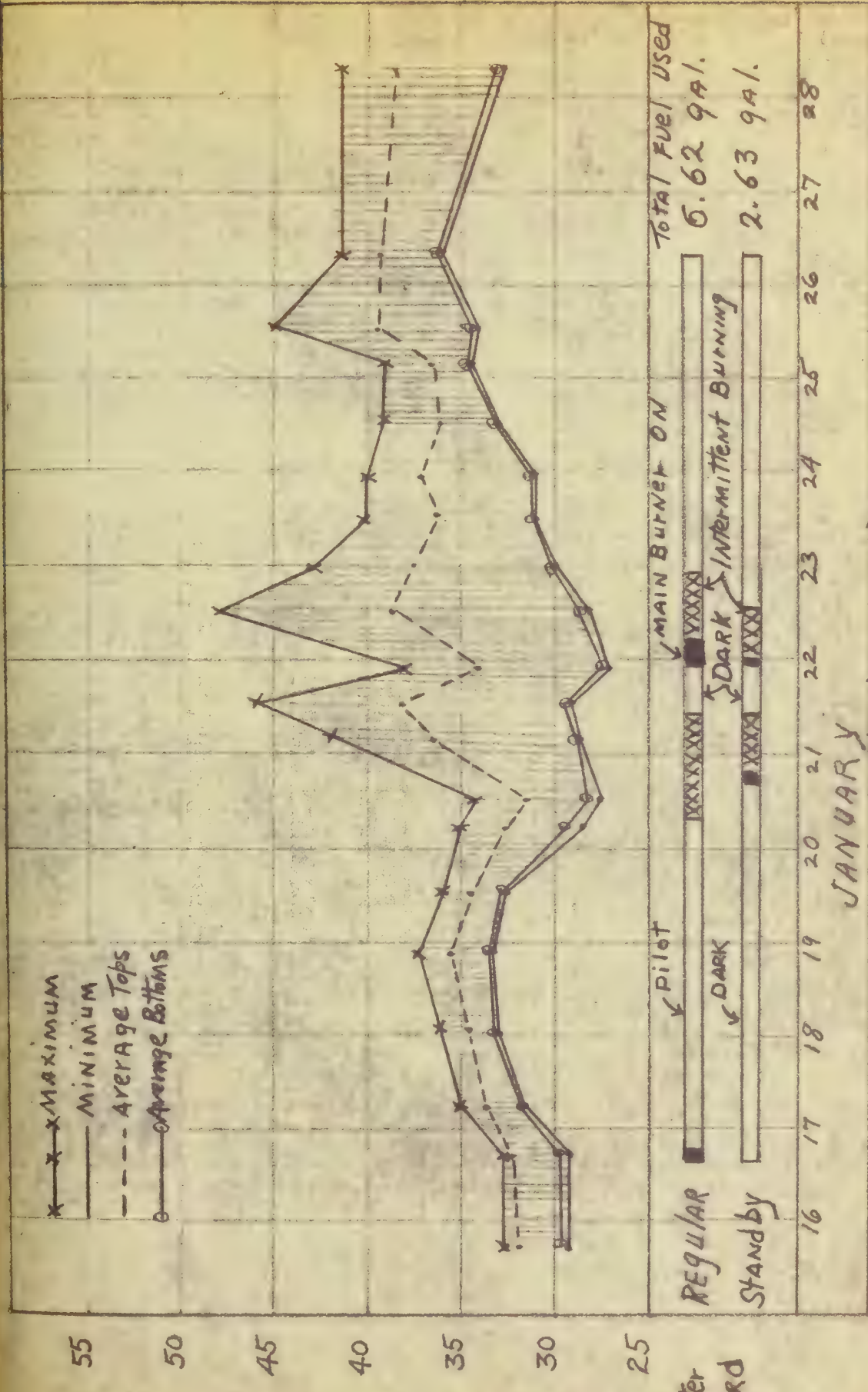
TAN OPERATION - SEAK

112

1946

TEMPERATURE ° F.

x x MAXIMUM
 — MINIMUM
 - - - Average Tops
 o Average Bottoms



Total Fuel Used
 6.62 gal.
 2.63 gal.



Date	Place
16	LOADING POINTS WASH.
17	Appleyard
18	Hillyard
19	Whitefish
20	HAVRE
21	Williston
22	THINOT
23	New Rockford
24	Breckenridge
25	WILLMAR
26	DAYTON BLUFF
27	E. WINONA
28	SAYANNA
29	Blue Island
30	DALTON
31	Columbus
32	PITCAIRN
33	ALTONA
34	ENOLA
35	Jersey City
36	Jersey City Unloading

Date and Place



x x MAXIMUM
 ——— MINIMUM
 - - - AVERAGE TOPS
 ○ ○ ○ AVERAGE BOTTOMS

TEMPERATURE
%



Total Fuel Used
 4.88 gal
 4.88 gal

MAIN BURNER ON
 INTERMITTENT BURNING

FRONT REAR

Pilot

28 27 26 25 24 23 22 21 20 19 18 17 16

JANUARY

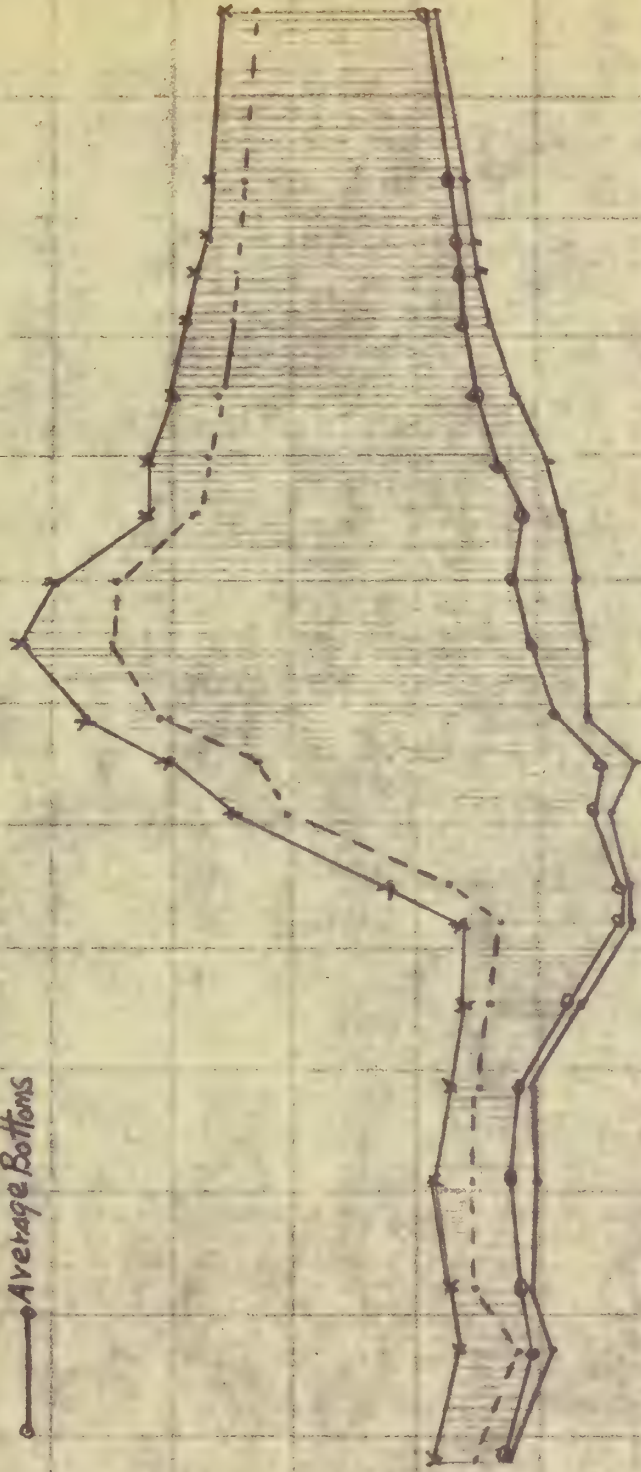
LOADING POINTS WASH	Appleyard	Whitefish	Hillyard	Williston	MINOT	New Rockford	Breckenridge	WILLMAR DAYTON BLUFF	E. WINONA	SARANNA	Blue Island	DALTON	Columbus	PITCAIRN	ALTONA ENOLA	Jersey City	N.Y. Pier 29
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TEMPERATURE °F.

x x Maximum
 — Minimum
 - - - Average Tops
 o — Average Bottoms

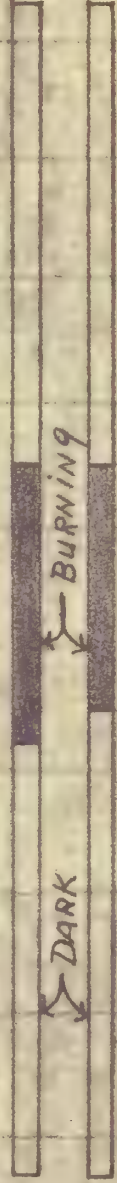
55
50
45
40
35
30
25



TOTAL FUEL USED

HEATER RECORD

FRONT
REAR



22.5 Lbs.

24.0 Lbs.

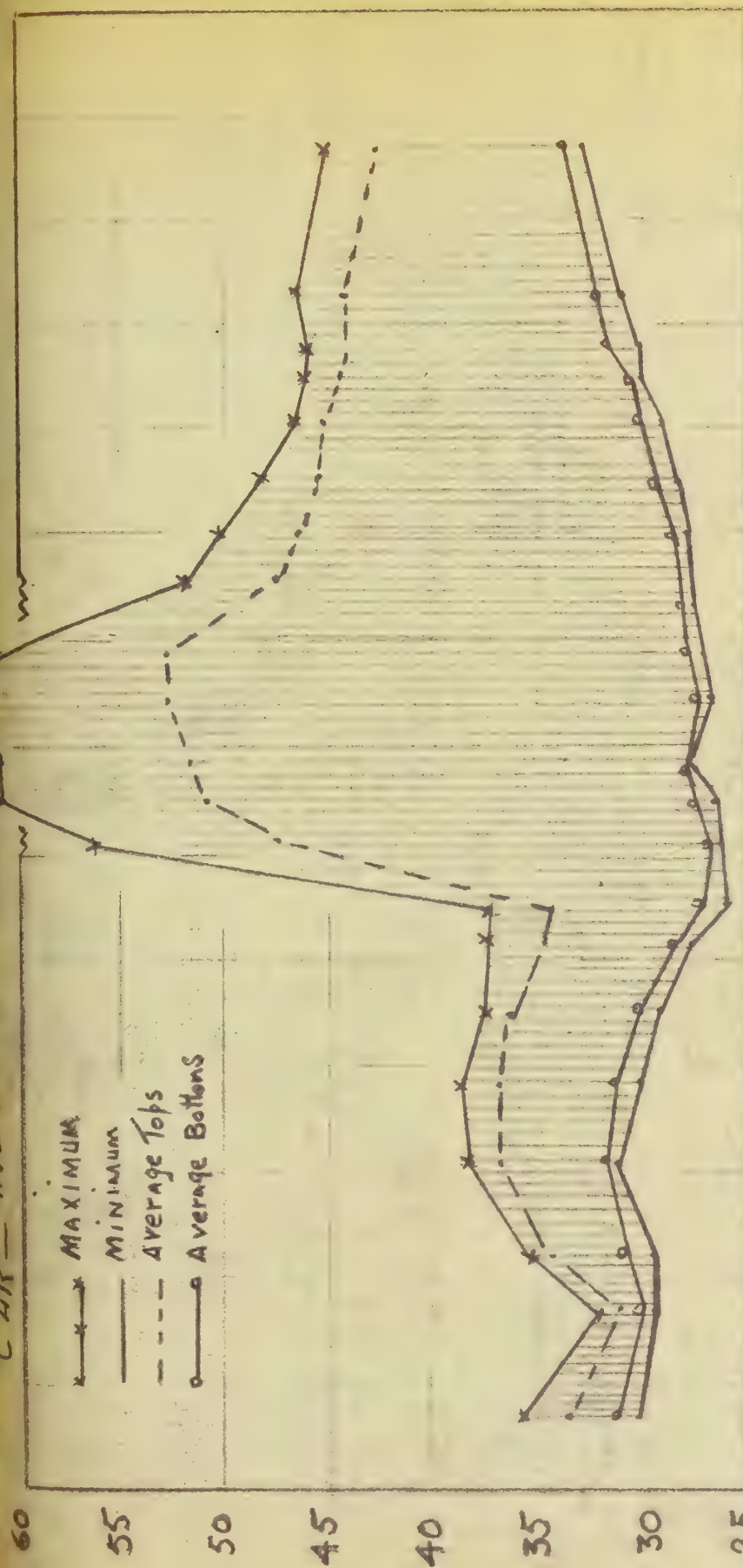
16 17 18 19 20 21 22 23 24 25 26 27 28

JANUARY

Loding POINTS WASH	Apple yard	Hillyard	Whitfish	HAVRE	Williston	THINOT	New Bedford	Beckenridge	Willmar	Dayton Bluff	E. WINONA	SAR ANNA	Bille Island	Dalton	Columbus	PITCAIRN	ALTONA	ENOIA	Jersey City	N.Y. Pier 29
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DATE AND PLACE

CAR - WFE 65784 STANDARD PFE Thermo. Alcohol - Both Ends



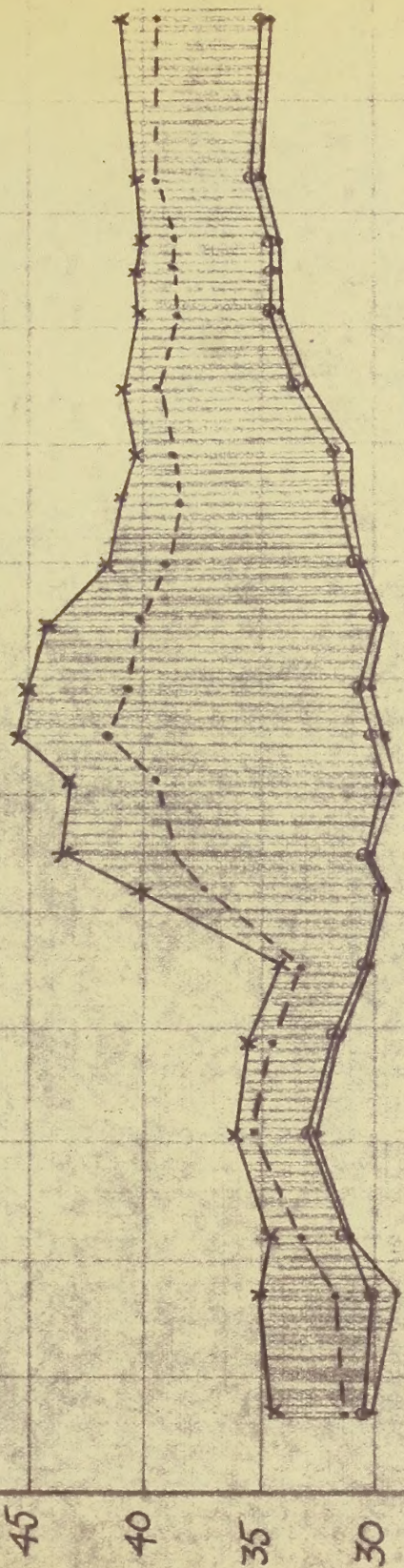
DATE	TEMPERATURE (°F)	HEATER RECORD	TOTAL FUEL USED
16	30		
17	32		
18	35		
19	38		
20	40		
21	55	FRONT (dashed), REAR (dashed)	
22	58	FRONT (solid), REAR (solid)	
23	55	FRONT (solid), REAR (solid)	
24	35	FRONT (dashed), REAR (solid)	
25	32	FRONT (dashed), REAR (solid)	
26	30	FRONT (dashed), REAR (solid)	
27	30	FRONT (dashed), REAR (solid)	
28	30	FRONT (dashed), REAR (solid)	

DATE	PLACE
16	WASH
17	Appkyard
18	Hillyard
19	HARE
20	Williston
21	MINOT
22	New Rockfort
23	Spec Kentidge
24	Willmar
25	Daytabluff
26	E. WILSONA
27	SAVANNA
28	Blue Island
	DALTON
	Columbus
	PICAI RN
	ALTONA
	Jersey City
	N.Y. Pt-a-28

DATE AND PLACE

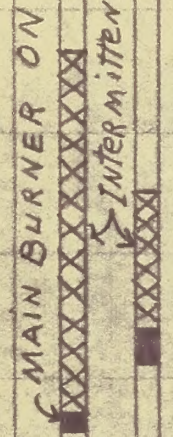
TEMPERATURE °F.

x — x MAXIMUM
 — MINIMUM
 - - - Average Tops
 o — Average Bottoms



HEATER RECORD

FRONT
REAR



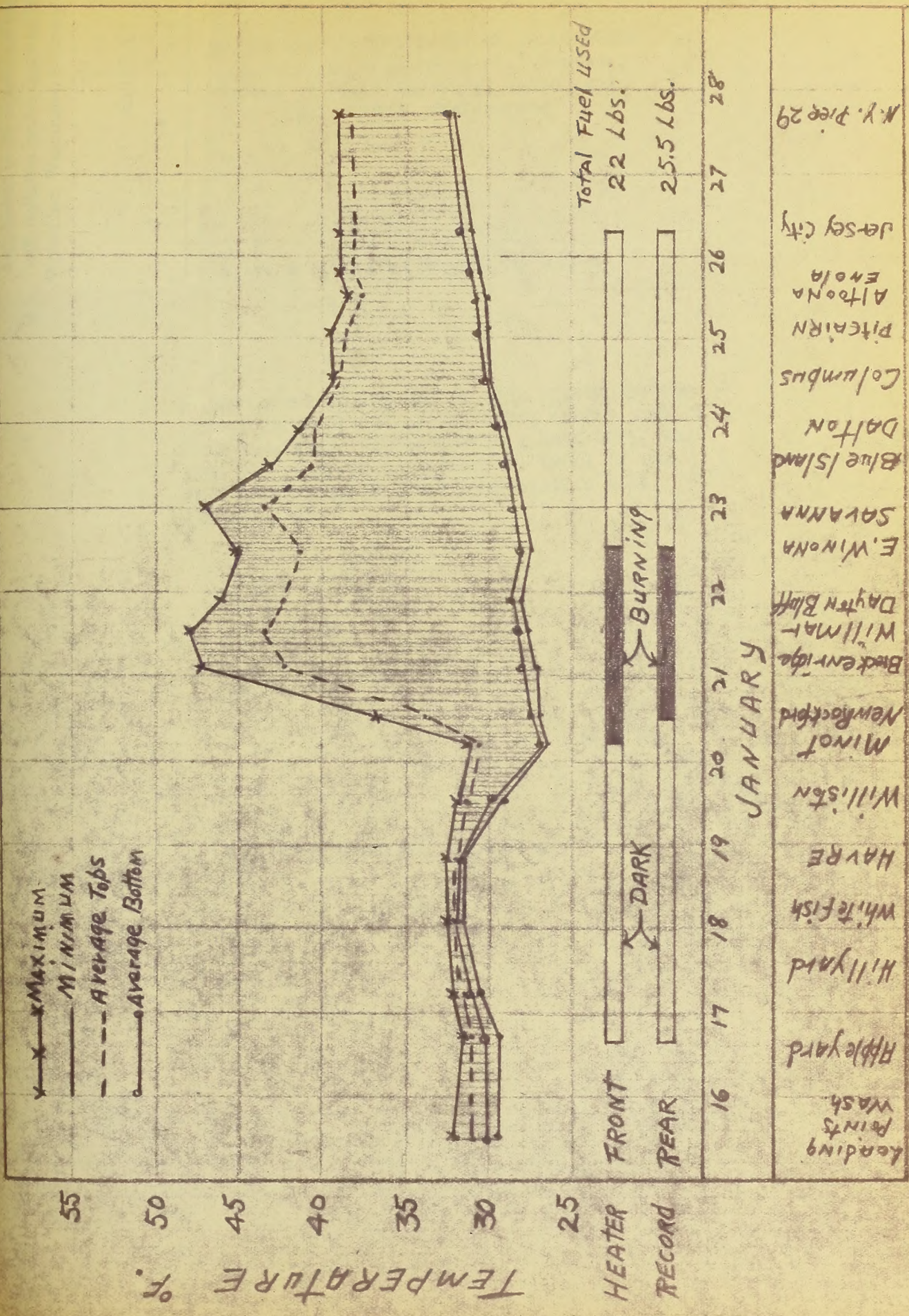
Total Fuel Used
6.13 gal
2.75 gal

16 17 18 19 20 21 22 23 24 25 26 27 28

JANUARY

loading points	WASH	Appleyard	Hillyard	Whitefish	HAVRE	Williston	Minot	New Rockford	Breckenridge	Willmar	Dayton Bluff	E. WINONA	SARAYNA	Blue Island	Dalton	Columbus	PITCAIRN	Altoona	ENOIA	Jersey City	N.Y. Pier 29
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Date And Place



DATE AND PLACE

TOTAL FUEL USED
 FRONT 22 LBS.
 REAR 25.5 LBS.

HEATER FRONT
 REAR RECORD

TEMPERATURE F.

x MAXIMUM
 — MINIMUM
 --- AVERAGE TOPS
 o AVERAGE BOTTOM

JANUARY

Leading
 Paints
 Wash
 Apple yard
 16
 17
 18
 19
 20
 21
 22
 23
 24
 25
 26
 27
 28
 29
 N.Y. Pier 29

